Patterns and Processes in South-Carpathian Wood-Pastures: An approach to analyse land-use driven landscape change in complex mountain landscapes

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General context: SNF-WindLand-project

- **WindLand**: Improved wind energy assessment based on coupled wind, terrain and vegetation modeling
- 2 study regions: RO and CH
- Landscape-change influences wind energy potential (terrain roughness)
- Track no.3: Landscape models and vegetation patterns
- Vegetation Change following dramatic land use changes in the post-com period.
Specific context

To present approach and early results of my PhD-project “Simulating landscape dynamics in pasture-woodlands of the Southern Carpathians following land use and climate change.”

Local scale approach (pasture-woodlands):

- Transfer of the WoodPaM model from the Jura Mts. to the Carpathians
- Calibration and initialization with very high resolution LiDAR-data (extent: several kilometers square).
- Analysis of model output with landscape metrics and link to LES (Large Eddy Simulations).
Research questions

In order to understand ongoing landscape change, we address the following research questions:

- What are the spatial patterns of forest encroachment in the Carpathian wood-pastures?
- What processes, driving factors and constraints can be deduced?
Structure of the talk

First steps of my PhD study here presented:

- Inspection of the study area,
- Interviews for understanding drivers of land use change,
- LiDAR-analysis,
- Ecological data,
- Synthesis from land-use and vegetation patterns: deduction of hypotheses on processes of long-term landscape dynamics from patterns
Methods

LiDAR data analysis
- Geomorphology. Goal: Identification of rock outcrops (safe sites for tree establishment)
- Potential identification of shrub and tree encroachment. Goal: reconstruction of processes from patterns at landscape scale
  ArcGIS, MatLab

Field observations
- Geomorphology
- Land-use structure
- Forest community
- Encroachment patterns

Landscape history analysis
- Old forest/grassland as hot-spots of historical continuity
  Method: time-depth analysis
  (Van Eetvelde et al. 2009, Pătru-Stupariu et al. 2013)

Interviews for understanding drivers of land use change
- Current land use
- Past land use

Synthesis of results
- Relating vegetation to land use change
- Formulating hypothesis on mechanisms of forest encroachment

Landscape change simulations
- Calibration, initialization, formulation of land use and climate change scenarios

WoodPaM-simulation model of wood-pasture ecosystem dynamics
  (Gillet 2008, Peringer et al. 2013)

Ecological data compilation
- Traits of dominant woody plant species
Study area: FUNDATA, Romania (Southern Carpathians, Rucăr- Bran Passageway)

- Altitude: 1160-1360 masl
- Geomorphology: karstic bedrock - limestone outcrops
- Climate: 4-6°C annual mean temperature; 915 mm average yearly precipitations sum (1961-2000); dry summers
- Dominant woody species: European beech *Fagus sylvatica*, Norway spruce *Picea abies*, Juniper *Juniperus communis*.
- Land-use: pastures (sheep and cattle) since XIVth Century
- Land-use change: abandonment in the post-communist period
Study area: FUNDATA, Romania  
(Southern Carpathians, Rucăr-Bran Passageway)

Google Earth View  
Shape area: 22 km²
Study sites selection

- 7 Study sites, which represent characteristic patterns of vegetation (shrub encroachment, forest communities) and land use (pasture size).
- Focus sites: 3, 2b, 6
Field obs. results
Site 3

- Steep slope, shallow soil with limestone outcrops on the hilltop, deep soil with no rocks at the foothill.
- Small scale fencing: Partly abandoned paddocks upslope, smaller paddocks intensely used downslope.
- Forest community dominated by spruce.
- Dense juniper and spruce encroachment uphill, no woody plants when management.
Field obs. results

Site 2b

- Medium declivity, more rock outcrops in the hilltop, less in the foothill.
- Large commonage pasture - no fences present.
- Forest community dominated by spruce.
- Scattered encroachment of juniper and spruce all over.
**Field obs. results**

**Site 6**

- Low declivity, few rock outcrops.
- Large commonage pasture - no fences present.
- Old forest*: beech dominance.
- Encroachment performed by spruce.

*Old forest (1912-2009), according to time-depth analysis*
LiDAR data inspection - Results

- 20-22 points per m²
- Classification with focus on lower vegetation (shrubs and young trees) (Korpela, I. 2010)
- High accuracy, low noise
- Obtained from special flight campaign

Site 2b
After the communist period, the migration of young population towards urban areas triggered land abandonment. This confirms the phenomenon pointed out by Kuemmerle et al. 2009, Munteanu et al. 2014.

Recent changes in ownership structure: inefficient management of the common pastureland.

Poor allocation of subsidies for wood-pasture maintenance.
### Ecological behavior of dominant woody species - Data compilation results

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth speed</th>
<th>Maximum age</th>
<th>Tolerance to shade</th>
<th>Browsing resistance</th>
<th>Distance of seed dispersal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beech (<em>F. silvatica</em>)</td>
<td>moderate</td>
<td>430 years</td>
<td>high</td>
<td>low</td>
<td>Low (low density long-distance zoochory)</td>
</tr>
<tr>
<td>Spruce (<em>P. abies</em>)</td>
<td>high</td>
<td>700 years</td>
<td>high</td>
<td>moderate</td>
<td>high</td>
</tr>
<tr>
<td>Juniper (<em>J. communis</em>)</td>
<td>high</td>
<td>150 years</td>
<td>low</td>
<td>high</td>
<td>Low (low density long-distance zoochory)</td>
</tr>
</tbody>
</table>

Synthesis: Patterns and processes

**Aim:** deduction of hypotheses on **processes** of long-term landscape dynamics from **patterns**:

- Land use structural shift (abandonment of large commonage pastures to the favor of small scale paddocks in rotational grazing systems) drives landscape segregation into intensive grassland and closed forest (see Western Europe). *(Landscape scale)*

- Beech dominates in natural/old forest, whereas spruce dominates in secondary succession (forest development in abandoned pastureland). --> *WoodPaM- simulation studies.* *(Community scale)*

- Ecological traits of spruce suggest fast and widespread encroachment, but upcoming summer droughts might inhibit establishment. --> *WoodPaM- simulation studies.* *(Population scale)*

- Rock outcrops play a crucial role for tree establishment, their presence accelerates encroachment and influences woody plant density. --> *LiDAR analysis.* *(Life process scale)*

- Subsidies need the definition of maintenance goals for wood-pasture management. --> *WoodPaM- simulation studies.* *(Landscape scale)*
Outlook

LiDAR data analysis:
- Identification of shrub and young tree, classification of encroachment patterns based on neighborhood analysis.
- Accurate estimate of height and crown diameter for age estimate from an allometric growth function (dendrochronological field study following Peringer 2008 Diss.)

WoodPaM simulations:
- Parameterize WoodPaM simulation model with processes data, then validate and calibrate model against patterns: Gillet 2008 and Peringer et al. 2013.
References


Thank you for listening!

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